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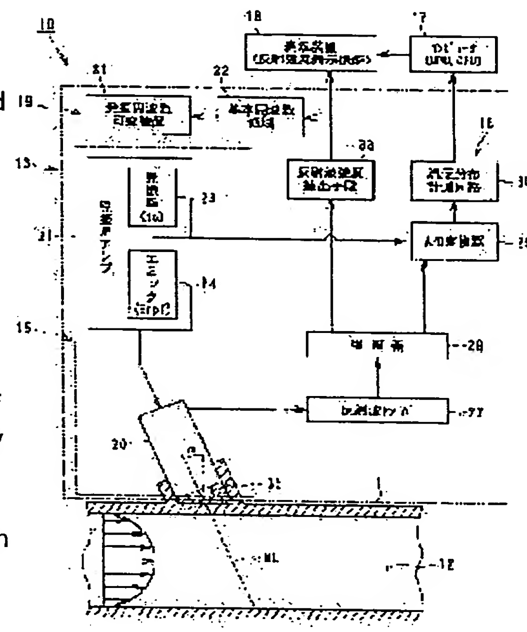
(54) DOPPLER-TYPE ULTRASONIC FLOWMETER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a high versatile Doppler-type ultrasonic flowmeter which can easily and accurately measure the flow rate of fluid to be measured flowing inside various kinds of fluid piping without being in contact.
SOLUTION: The Doppler-type ultrasonic flowmeter is composed of an ultrasonic transmitting means 15 which injects ultrasonic wave pulses into a fluid pipe 11 from an ultrasonic transducer 20, a means for measuring distribution of fluid velocity 16 which receives ultrasonic echoes reflected from a measuring region in the fluid pipe 11 and measures the distribution of fluid velocity of the fluid to be measured 12, a means for calculating flow rate of fluid 17 which calculates the flow rate from the distribution of fluid velocity of the fluid to be measured 12, and a setting means for selecting frequency 19 which automatically selects the basic frequency of the ultrasonic wave causing a resonating/ transmitting phenomenon from the ultrasonic transducer 20. The setting means for selecting frequency 19 controls and drives the ultrasonic transmitting means 15 so that the ultrasonic wave with an optimal frequency selected is transmitted from the ultrasonic transducer 20.



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CLAIMS

[Claim(s)]

[Claim 1] An ultrasonic transmitting means to carry out incidence of the ultrasonic pulse to the measured fluid which flows the inside of fluid piping from an ultrasonic transducer, A velocity-distribution measurement means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses by which incidence was carried out to the measured fluid, and to measure the velocity distribution of the measured fluid in the above-mentioned measurement field, A fluid flow rate operation means to compute the flow rate of a measured fluid based on the velocity distribution of the above-mentioned measured fluid, It has a frequency-selective setting means to choose automatically the fundamental frequency of the supersonic wave which produces a resonance-transparency phenomenon from an ultrasonic transducer to the tube wall of said fluid piping. This frequency complement setting means is a Doppler type ultrasonic flowmeter characterized by carrying out actuation control of said ultrasonic transmitting means so that the supersonic wave of the selected optimum frequency may be oscillated from an ultrasonic transducer.

[Claim 2] Said oscillation frequency complement setting means is the Doppler type ultrasonic flowmeter according to claim 1 with which the oscillation frequency of an ultrasonic pulse was chosen so that an accommodation setup of the oscillation frequency of the ultrasonic pulse oscillated from an ultrasonic transducer might be carried out automatically and the integral multiple of the ultrasonic half-wave length might serve as wall thickness of fluid piping.

[Claim 3] The amplifier for an oscillation with which said oscillation frequency complement setting means oscillates the supersonic wave of a necessary oscillation frequency from an ultrasonic transducer, The oscillation frequency adjustable equipment which enables an accommodation setup of adjustable [of the oscillation frequency of this amplifier for an oscillation], A frequency-domain setting means to operate oscillation frequency adjustable equipment in the frequency domain specified beforehand, An ultrasonic receiving means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses oscillated from said ultrasonic transducer, It is the Doppler type ultrasonic flowmeter according to claim 1 or 2 with which it had the reflected wave on-the-strength extract means which extracts the reinforcement of the received ultrasonic echo and is made to memorize, and extract selection actuation of an oscillation frequency is repeatedly performed, and the optimum frequency of a supersonic wave chose said oscillation frequency-selective setting means automatically.

[Claim 4] Said Doppler type ultrasonic flowmeter is further equipped with the incident angle accommodation setting means which carries out an accommodation setup of whenever [incident angle / of the ultrasonic pulse by which incidence is carried out into a measured fluid from said ultrasonic transducer]. So that this incident angle accommodation setting means may serve as whenever [incident angle / which an ultrasonic pulse makes produce a resonance-transparency phenomenon to the tube wall of fluid piping] The Doppler type ultrasonic flowmeter according to claim 1 which prepared the ultrasonic transducer in fluid piping possible [an accommodation setup], and combined said frequency-selective setting means and the incident angle accommodation setting means.

[Claim 5] An ultrasonic transmitting means to carry out incidence of the ultrasonic pulse to the measured fluid which flows the inside of fluid piping from an ultrasonic transducer, A fluid velocity-distribution measurement means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses by which incidence was carried out to the measured fluid, and to measure the velocity distribution of the measured fluid in the above-mentioned measurement field, A fluid flow rate operation means to compute the flow rate of a measured fluid based on the velocity distribution of the above-mentioned measured fluid, It has the incident angle accommodation setting means which carries out an accommodation setup of whenever [incident angle / of the ultrasonic pulse by which incidence is carried out into a measured fluid from said ultrasonic transducer]. This incident angle accommodation setting means The Doppler type ultrasonic flowmeter characterized by preparing an ultrasonic transducer in fluid piping possible [an accommodation setup] so that it may become whenever [angle-of-incidence / which an ultrasonic pulse makes produce a resonance-transparency phenomenon to the tube wall of fluid piping].
[Claim 6] The ultrasonic transducer by which said angle-of-incidence accommodation means was formed in fluid piping from the outside, Whenever [incident angle / of the ultrasonic pulse oscillated from this ultrasonic transducer] The incident angle translator in which an accommodation setup is possible, An incident angle field setting means to operate the above-mentioned incident angle translator within the limits of the incident angle field specified beforehand, Receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses oscillated from said ultrasonic transducer, and the reinforcement of an ultrasonic echo is extracted. It is the Doppler type ultrasonic flowmeter according to claim 5 with which it had a reflected wave on-the-strength extract means to memorize, and extract selection actuation of whenever [ultrasonic pulse incident angle] is repeatedly performed, and said incident angle accommodation setting means chose whenever [optimal ultrasonic pulse incident angle] automatically.
[Claim 7] Said ultrasonic transducer is the Doppler type ultrasonic flowmeter according to claim 5 or 6 which carried out an accommodation setup of whenever [angle-of-incidence / of the ultrasonic pulse oscillated from an ultrasonic transducer] by preparing whenever [champing-angle] in the outside of fluid piping free [accommodation], and choosing whenever [champing-angle / of the above-mentioned ultrasonic transducer] by the angle-of-incidence translator.
[Claim 8] It is the Doppler type ultrasonic flowmeter which is equipped with the ultrasonic transducer migration device make the 1st supersonic wave by which it was prepared in fluid piping, a transducer, the 2nd ultrasonic transducer estranged and prepared in the shaft orientations of fluid piping from this ultrasonic transducer, and the 1st ultrasonic transducer move relatively [transducer / 2nd / ultrasonic], and is characterized by to be arranged both said supersonic-waves transducer so that the ultrasonic pulse oscillated may intersect perpendicularly in the measurement field in fluid piping.
[Claim 9] With the reflected wave receiver which receives the ultrasonic echo which is a reflected wave, respectively from the measurement field in fluid piping of the ultrasonic pulse by which said Doppler type ultrasonic flowmeter was oscillated from said 1st and 2nd ultrasonic transducers A velocity vector calculation means to compute the velocity vector of the direction of an ultrasonic measurement line from the ultrasonic echo reinforcement received with each reflected wave receiver, respectively, It has further a rate-of-flow vector calculation means to compute the rate-of-flow vector of a measured fluid from the vector sum of the velocity vector computed with each velocity vector calculation means. The Doppler type ultrasonic flowmeter according to claim 8 which computes the flow rate of a measured fluid from the velocity distribution of the direction of a measurement line in fluid piping computed with the rate-of-flow vector calculation means.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the Doppler type ultrasonic flowmeter which measures the flow rate of a measured fluid using the doppler shift of a supersonic wave, especially adjusts automatically whenever [optimum frequency / of a supersonic wave /, or optimal incident angle], and relates to the Doppler type ultrasonic flowmeter which can be set up.
[0002]
[Description of the Prior Art] It is divided roughly into the flowmeter which measures the rate of flow and flow rate of the measured fluid which flows the inside of fluid piping by two kinds by the measurement principle.
[0003] The 1st flowmeter measures a flow rate using the amount of processes of flowing fluid changing the inside of fluid piping to a flow direction, and there is an orifice meter in this kind of flowmeter. An orifice meter measures a flow rate by the orifice upstream and the downstream using the pressures of a fluid differing, and calls such a flow rate measurement approach "average approximation" below.
[0004] The 2nd flowmeter is mainly used for the hydrometry of the flow in piping, such as a tube.

[0005] The rate of flow of an one point of the flow in piping, for example, the predetermined point on a tube axis, is measured, the velocity-distribution configuration in piping is assumed from a theoretical value based on the obtained measured value, this flowmeter is integrated with this velocity-distribution configuration, and a flow rate is calculated. Such a hydrometry approach is called "approximation integration" below.
[0006] The ultrasonic flowmeter which irradiates a supersonic wave at the measured fluid which is the measuring object, and measures the flow rate of a fluid in a flowmeter on the other hand is known.
[0007] It is divided roughly into what measures a flow rate by average approximation in this ultrasonic flowmeter, and the thing which measures a flow rate by approximation integration.
[0008] The ultrasonic flowmeter which adopted average approximation is with the case where an ultrasonic pulse progresses towards the upstream of the flow of a fluid in the time amount taken for an ultrasonic pulse to pass through for two points of fixed spacing, and that case where it progresses towards the lower stream of a river of flow conversely, it uses that only the rates of the flow of a fluid differ, asks for the mean velocity for two predetermined points, and measures a flow rate.
[0009] Moreover, the ultrasonic flowmeter which adopted approximation integration finds the rate of the measured fluid of one on the medial axis of piping using the doppler shift method, measures a flow rate from this fluid rate, and has some which were indicated by JP,6-294670,A. The ultrasonic flowmeter of this approximation integration is integrated in quest of the form of a velocity distribution from a theoretical value or a rule of thumb. For example, in the laminar-flow field in piping, since a velocity distribution appears in a parabola, it can calculate a flow rate by using the boundary condition in a tube wall using the fluid rate measured on the medial axis.

Since this theoretical solution is strictly materialized to the flow of a steady state, the ultrasonic flowmeter of approximation integration can be applied only to the flow of a steady state, and cannot respond to the flow of an unstationary state.

[0010] Generally, the flow of viscous fluid is well known as an equation (henceforth a NS equation) of Navia SUTOUSUKU (Navier-Stokes). The conventional ultrasonic flowmeter disregards the time amount differential term of a NS equation, and is calculating the flow rate using the knowledge of flow distribution over a steady state. For this reason, a flow rate is changed in time, when the flowing space (flow field of a fluid) where approximation integration is not enacted is the measuring object, the accuracy of measurement falls remarkably or there is a possibility that the effectiveness of a measurement result may be spoiled.

[0011] The flowing space where the fluctuation time amount of a flow rate system is shorter than time amount required as such flowing space to take out an average stream flow, and the flowing space where flow is not fully developed are mentioned. In the case of the former, the time amount differential term of a NS equation does not become zero, and, in the case of the latter, single dimension approximation of a NS equation is not materialized.

[0012] Since it was flow rate measurement of the flow of a steady state while it is necessary to take the very long in-run who makes the upstream of for example, a measurement part stationary-ize flow and the conventional flowmeter takes time amount, cost, and an effort in a piping facility, in order to be flow rate measurement in a steady state and to perform hydrometry in sufficient precision, it was difficult to perform flow rate measurement of the flow of an unstationary state.

[0013] Moreover, since the conventional flowmeter makes the average stream flow of flowing fluid the measuring object for the inside of closed piping, such as a tube, it cannot measure the local flow rate of a bigger flow rate system. For example, the characteristic flow rate measurement accompanied by the time variation near the inlet port of a very big mixing vessel or near an outlet was not able to be measured in which flowmeter.

[0014] By the way, to the flow of the measured fluid in the flow rate place of three-dimensions space being expressed with the vector quantity of three dimensions, in piping, the conventional flowmeter assumes the flow of a single dimension and performs flow rate measurement. For this reason, even if it is in closed piping, when flow is in three dimensions, the accuracy of measurement of a flow rate gets very bad, or becomes impossible. For example, immediately after piping bent like elbow piping or U character-like reversal piping, the flow of a fluid is in three dimensions according to a centrifugal-force operation, and even if it installs the conventional flowmeter in such a location, flow rate measurement cannot be performed correctly.

[0015] Then, this invention person etc. proposed the Doppler type ultrasonic flowmeter which can measure the flow rate of a measured fluid with a sufficient precision according to non-contact correctly by the time-dependent even if it is the flow of an unstationary state on the Japanese-Patent-Application-No. No. 272359 [ten to] specifications using the doppler shift of a supersonic wave.

[0016] This Doppler type ultrasonic flowmeter applied the technique of computing a direct flow rate from the momentary velocity distribution of the measured fluid which flows the inside of fluid piping, and carried out the knowledge of having a high precision and responsibility in flow rate measurement of a measured fluid.

[0017]

[Problem(s) to be Solved by the Invention] Also in the conventional Doppler type ultrasonic flowmeter, to perform flow rate measurement of the measured fluid which flows the inside of fluid piping with simple and big versatility is desired.

[0018] In order to measure smoothly and smoothly the rate of flow of the measured fluid which flows the inside of fluid piping various with a Doppler type ultrasonic flowmeter, it is necessary to fully secure the transparency effectiveness of a supersonic wave also to fluid piping of various wall thickness, and to secure sufficient reflected wave S/N ratio.

[0019] In the conventional Doppler type ultrasonic flowmeter, the transparency property of the metal wall of a supersonic wave was investigated by changing the thickness of a metal wall, and

it has set up so that the thickness of fluid piping may become the optimal.
[0020] However, by application to the system of a Doppler type ultrasonic flowmeter, it is impossible to change various thickness of fluid piping, the ultrasonic flowmeter which has the optimal ultrasonic transparency property for every class of fluid piping must be prepared, and versatility is low.
[0021] This invention was made in consideration of the situation mentioned above, and sets it as the main purposes to offer the high Doppler type ultrasonic flowmeter of the versatility which can, easy moreover, measure correctly the flow rate of the measured fluid which flows the inside of various fluid piping with a sufficient precision by easy and non-contact.
[0022] Other purposes of this invention select automatically whenever [optimum frequency / of the supersonic wave which produces a resonance-transparency phenomenon to the various wall thickness of fluid piping /, or optimal incident angle / of a supersonic wave], and are to offer the Doppler type ultrasonic flowmeter which can measure the flow rate of a measured fluid with a sufficient precision correctly using the doppler shift of a supersonic wave.
[0023] Furthermore, even if other purposes of this invention are the opaque or translucent liquids which cannot apply the optical hydrometry approach, they are to offer the Doppler type ultrasonic flowmeter which can measure a flow rate with a sufficient precision correctly.
[0024] Another purpose of this invention is to offer the Doppler type ultrasonic flowmeter which can measure correctly the measured fluid which flows the inside of fluid piping with a sufficient precision, even if a revolution style and the flow which is not parallel to piping arise within fluid piping.
[0025]
[Means for Solving the Problem] In order that the Doppler type ultrasonic flowmeter concerning this invention may solve the technical problem mentioned above An ultrasonic transmitting means to carry out incidence of the ultrasonic pulse to the measured fluid which flows the inside of fluid piping from an ultrasonic transducer as indicated to claim 1, A velocity-distribution measurement means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses by which incidence was carried out to the measured fluid, and to measure the velocity distribution of the measured fluid in the above-mentioned measurement field, A fluid flow rate operation means to compute the flow rate of a measured fluid based on the velocity distribution of the above-mentioned measured fluid, It has a frequency-selective setting means to choose automatically the fundamental frequency of the supersonic wave which produces a resonance-transparency phenomenon from an ultrasonic transducer to the tube wall of said fluid piping. This frequency complement setting means carries out actuation control of said ultrasonic transmitting means so that the supersonic wave of the selected optimum frequency may be oscillated from an ultrasonic transducer.
[0026] In order to solve the technical problem mentioned above, moreover, the Doppler type ultrasonic flowmeter concerning this invention As indicated to claim 2, said oscillation frequency-selective setting means An accommodation setup of the oscillation frequency of the ultrasonic pulse oscillated from an ultrasonic transducer is carried out automatically. As the oscillation frequency of an ultrasonic pulse was chosen so that the integral multiple of the ultrasonic half-wave length might serve as wall thickness of fluid piping, and indicated to claim 3, further said oscillation frequency-selective setting means The amplifier for an oscillation which oscillates the supersonic wave of a necessary oscillation frequency from an ultrasonic transducer, The oscillation frequency adjustable equipment which enables an accommodation setup of adjustable [of the oscillation frequency of this amplifier for an oscillation], A frequency-domain setting means to operate oscillation frequency adjustable equipment in the frequency domain specified beforehand, An ultrasonic receiving means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses oscillated from said ultrasonic transducer, The reinforcement of the received ultrasonic echo is extracted, it has the reflected wave on-the-strength extract means made to memorize, and extract selection actuation of an oscillation frequency is performed repeatedly, and the optimum frequency of a supersonic wave chooses said oscillation frequency-selective setting means automatically.

[0027] In order to solve the technical problem mentioned above, furthermore, the Doppler type ultrasonic flowmeter concerning this invention As indicated to claim 4, said Doppler type ultrasonic flowmeter It has further the incident angle accommodation setting means which carries out an accommodation setup of whenever [incident angle / of the ultrasonic pulse by which incidence is carried out into a measured fluid from said ultrasonic transducer]. This incident angle accommodation setting means An ultrasonic transducer is prepared in fluid piping possible [an accommodation setup], and said frequency-selective setting means and an angle-of-incidence accommodation setting means are combined so that it may become whenever [angle-of-incidence / which an ultrasonic pulse makes produce a resonance-transparency phenomenon to the tube wall of fluid piping].
[0028] On the other hand, the Doppler type ultrasonic flowmeter concerning this invention An ultrasonic transmitting means to carry out incidence of the ultrasonic pulse to the measured fluid which flows the inside of fluid piping from an ultrasonic transducer as indicated to claim 5 in order to solve the technical problem mentioned above, A fluid velocity-distribution measurement means to receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses by which incidence was carried out to the measured fluid, and to measure the velocity distribution of the measured fluid in the above-mentioned measurement field, A fluid flow rate operation means to compute the flow rate of a measured fluid based on the velocity distribution of the above-mentioned measured fluid, It has the incident angle accommodation setting means which carries out an accommodation setup of whenever [incident angle / of the ultrasonic pulse by which incidence is carried out into a measured fluid from said ultrasonic transducer]. This incident angle accommodation setting means An ultrasonic transducer is prepared in fluid piping possible [an accommodation setup] so that it may become whenever [angle-of-incidence / which an ultrasonic pulse makes produce a resonance-transparency phenomenon to the tube wall of fluid piping].
[0029] In order to solve the technical problem mentioned above, furthermore, the Doppler type ultrasonic flowmeter concerning this invention As indicated to claim 6, said incident angle accommodation means Whenever [incident angle / of the ultrasonic pulse oscillated from the ultrasonic transducer prepared in fluid piping from the outside, and this ultrasonic transducer] The incident angle translator in which an accommodation setup is possible, An incident angle field setting means to operate the above-mentioned incident angle translator within the limits of the incident angle field specified beforehand, Receive the ultrasonic echo reflected from the measurement field in fluid piping among the ultrasonic pulses oscillated from said ultrasonic transducer, and the reinforcement of an ultrasonic echo is extracted. It has a reflected wave on-the-strength extract means to memorize. Said incident angle accommodation setting means As extract selection actuation of whenever [ultrasonic pulse incident angle] is performed repeatedly, and whenever [optimal ultrasonic pulse incident angle] is chosen automatically and being further indicated to claim 7 Whenever [champing-angle] is prepared in the outside of fluid piping free [accommodation], and said ultrasonic transducer carries out an accommodation setup of whenever [angle-of-incidence / of the ultrasonic pulse oscillated from an ultrasonic transducer] by choosing whenever [champing-angle / of the above-mentioned ultrasonic transducer] by the angle-of-incidence translator.
[0030] On the other hand, the Doppler type ultrasonic flowmeter concerning this invention The 1st supersonic wave and transducer which were prepared in fluid piping as indicated to claim 8 in order to solve the technical problem mentioned above, The 2nd ultrasonic transducer estranged and prepared in the shaft orientations of fluid piping from this ultrasonic transducer, It has the ultrasonic transducer migration device in which the 1st ultrasonic transducer is made to move relatively [transducer / 2nd / ultrasonic], and said both supersonic-waves transducer is arranged so that the ultrasonic pulse oscillated may intersect perpendicularly in the measurement field in fluid piping.
[0031] In order to solve the technical problem mentioned above, furthermore, the Doppler type ultrasonic flowmeter concerning this invention As indicated to claim 9, said Doppler type ultrasonic flowmeter With the reflected wave receiver which receives the ultrasonic echo which is a reflected wave, respectively from the measurement field in fluid piping of the ultrasonic pulse

oscillated from said 1st and 2nd ultrasonic transducers A velocity vector calculation means to compute the velocity vector of the direction of an ultrasonic measurement line from the ultrasonic echo reinforcement received with each reflected wave receiver, respectively, It has further a rate-of-flow vector calculation means to compute the rate-of-flow vector of a measured fluid from the vector sum of the velocity vector computed with each velocity vector calculation means, and the flow rate of a measured fluid is computed from the velocity distribution of the direction of a measurement line in fluid piping computed with the rate-of-flow vector calculation means.

[0032]

[Embodiment of the Invention] The gestalt of operation of the Doppler type ultrasonic flowmeter concerning this invention is explained with reference to an accompanying drawing.

[0033] Drawing 1 is drawing showing the 1st operation gestalt of the Doppler type ultrasonic flowmeter concerning this invention. The Doppler type ultrasonic flowmeter 10 measures the velocity distribution of the measured fluids 12, such as a liquid which flows the inside of the fluid piping 11, and a gas, and measures a flow rate by the time-dependent in an instant.

[0034] The Doppler type ultrasonic flowmeter 10 is equipped with the ultrasonic velocity-distribution measurement unit (henceforth a UVP unit) 13 which measures the rate of flow of the measured fluid 12 which flows the inside of the fluid piping 11 by non-contact. An ultrasonic transmitting means 15 by which the UVP unit 13 makes the ultrasonic pulse of a necessary frequency (fundamental frequency f0) transmit to the measured fluid 12 along with the measurement line ML, A fluid velocity-distribution measurement means 16 to receive the ultrasonic echo which is a reflected wave from the measurement field of the ultrasonic pulse by which incidence was carried out to the measured fluid 12, and to measure the velocity distribution of the measured fluid 12 in a measurement field, The computers 17, such as a microcomputer as a fluid flow rate operation means to carry out data processing based on the velocity distribution of the measured fluid 12, to integrate with radial, and to calculate the flow rate of the measured fluid 12 by the time-dependent, and CPU, MPU, It has a frequency-selective setting means 19 to select automatically the supersonic wave of the optimum frequency of the measured fluid 12 which flows the display 18 which can be displayed serially, and the fluid piping 11 in the output from this computer 17.

[0035] The ultrasonic transmitting means 15 has the ultrasonic transducer 20 which oscillates the ultrasonic pulse of a necessary frequency, and the amplifier 21 for an oscillation as a signal generator which oscillates this ultrasonic transducer 20. The amplifier 21 for an oscillation is equipped with the oscillator (oscillator) 23 made to generate the electrical signal of the necessary fundamental frequency f0, and the emitter 24 (frequency Frpf) which outputs the electrical signal from this oscillator 23 in the shape of a pulse to predetermined every time interval (1-/Frpf), and the pulse electrical signal of the necessary fundamental frequency f0 is inputted into the ultrasonic transducer 20 from the amplifier 21 for an oscillation which is this signal generator.

[0036] The ultrasonic pulse of fundamental frequency f0 is made to send the ultrasonic transducer 20 along with the measurement line ML by impression of a pulse electrical signal. An ultrasonic pulse is a beam of rectilinear-propagation nature which has almost no flare with the pulse width of about 5mm.

[0037] The ultrasonic transducer 20 serves as the transceiver machine, and the ultrasonic transducer 20 receives the ultrasonic echo in which the sent ultrasonic pulse is reflected in the reflector in a fluid. A reflector is a foreign matter with which it is the air bubbles uniformly contained in the measured fluid 12, or is particle, such as metaled impalpable powder, or acoustic impedances differ in the measured fluid 12.

[0038] It is received by the reflected wave receiver 27 and the ultrasonic echo received by the ultrasonic transducer 20 is changed into an echo electrical signal with this reflected wave receiver 27. After this echo electrical signal is amplified with an amplifier 28, digital processing is carried out through A/D converter 29, and it is inputted into the velocity-distribution measurement circuit 30 where this digital echo signal constitutes a fluid velocity-distribution measurement means. The electrical signal of the fundamental frequency f0 from the amplifier 21

for an oscillation is digitized by the velocity-distribution measurement circuit 30, it is inputted into it, change of the rate of flow based on a doppler shift is measured from the delta frequency of both signals in it, and the velocity distribution of the measurement field which meets the measurement line ML is computed in it. The velocity distribution in the cross section of the fluid piping 11 is measurable by proofreading the velocity distribution of a measurement field with the tilt angle alpha.

[0039] On the other hand, an optimum value is chosen with the frequency-selective setting means 19 so that the fundamental frequency f0 of the ultrasonic pulse oscillated from the ultrasonic transducer 20 may produce a resonance-transparency phenomenon to the wall thickness of the fluid piping 11. The metal wall transparency property of a supersonic wave carried out the knowledge of the very high thing, when the wall thickness of the fluid piping 11 was 1/2 of the fundamental frequency f0 of a supersonic wave, or its integral multiple.

[0040] The frequency-selective setting means 19 which can choose freely and automatically the necessary fundamental frequency f0 which produces a resonance-transparency phenomenon is incorporated to various kinds of fluid piping 11, without changing the thickness of the tube wall of the fluid piping 11 to this Doppler type ultrasonic flowmeter 10 based on this knowledge.

[0041] The amplifier 21 for an oscillation with which this frequency complement setting means 19 oscillates the supersonic wave of a necessary oscillation frequency (fundamental frequency f0) from an ultrasonic transducer, The oscillation frequency adjustable equipment 31 which enables an accommodation setup of adjustable [of the oscillation frequency of this amplifier 21 for an oscillation], A fundamental-frequency field setting means 32 to operate oscillation frequency adjustable equipment 31 within limits beforehand specified as this oscillation frequency adjustable equipment 31, for example, the inside of a 200kHz - 4MHz frequency domain, With the reflected wave receiver 27 as an ultrasonic receiving means which receives the ultrasonic echo reflected from the measurement field in said fluid piping 11 The reflected wave on-the-strength extract means 33 which extracted the reinforcement of an ultrasonic echo signal and was equipped with the memory made to memorize after amplifying the received ultrasonic echo signal with amplifier 28, It has the display 18 equipped with the reflected wave display function on the strength as which it is extracted by this reflected wave on-the-strength extract means 33, and the memorized reflectivity (ultrasonic echo reinforcement) is displayed.

[0042] Although a deer is carried out, the frequency complement setting means 19 carries out excitation of the ultrasonic transducer 20 with the amplifier 21 for an oscillation and an ultrasonic pulse is oscillated, the oscillation frequency f0 of the amplifier 21 for an oscillation is determined based on the output signal of oscillation frequency adjustable equipment 31. In the frequency domain beforehand appointed with the fundamental-frequency field setting means 32, oscillation frequency adjustable equipment 31 has set up the oscillation frequency of the amplifier 21 for an oscillation free [adjustable].

[0043] Extract selection actuation of the oscillation frequency of a supersonic wave is repeatedly performed by collaboration operation of the reflected wave on-the-strength extract means 33 and oscillation frequency adjustable equipment 31 grade, the optimum frequency of the supersonic wave which produces a resonance-transparency phenomenon to the wall thickness of the fluid piping 11 is chosen automatically, and the frequency-selective setting means 19 is set up.

[0044] If the optimum frequency of a supersonic wave is chosen and set up, the oscillation frequency of the amplifier 21 for an oscillation will be determined by the output signal from oscillation frequency adjustable equipment 31, excitation of the ultrasonic transducer 20 will be carried out with this amplifier 21 for an oscillation, and the ultrasonic pulse of the necessary fundamental frequency f0 which is optimum frequency will be sent in the fluid piping 11 from the ultrasonic transducer 20.

[0045] Since the ultrasonic pulse of optimum frequency is sent from the ultrasonic transducer 20, sufficient reflected wave S/N ratio can be secured and the large signal of the ultrasonic echo which is a reflected wave can be taken. In order to take a large ultrasonic echo signal, it is important to choose the fundamental frequency f0 of the supersonic wave which produces a resonance-transparency phenomenon to the wall thickness (wall thickness of the measurement

line ML direction) of the fluid piping 11.
[0046] If the wall thickness of the fluid piping 11 becomes the integral multiple of the ultrasonic half-wave length, according to a mesomeric effect, the ultrasonic permeability in the interface of the fluid piping 11 will increase remarkably, and the ultrasonic echo signal which is a reflected wave from the reflector of the measured fluid 12 will increase as a result of increase of ultrasonic permeability.
[0047] Therefore, if the optimal fundamental frequency f0 is chosen for the oscillation frequency of the ultrasonic pulse oscillated from the ultrasonic transducer 20 to the wall thickness of the fluid piping 11 by the frequency complement setting means 19, since attenuation in an ultrasonic path (transit way of the measurement line ML direction) will become small and the ultrasonic permeability in the interface of the fluid piping 11 will increase, sufficient reflected wave reinforcement can be obtained.
[0048] In addition, in drawing 1 , a sign 35 is the contact medium which might make it have made it oscillate smoothly the supersonic wave oscillated from the ultrasonic transducer 20 in the fluid piping 11. The contact medium 35 is formed in order to make small the acoustic impedance by which is oscillated from the ultrasonic transducer 20 and incidence is carried out into the fluid piping 11 and to make sound switching good.
[0049] Moreover, although the reflected wave receiver 27 received the ultrasonic echo which is the reflected wave of an ultrasonic pulse with the 1st operation gestalt, it is not necessary to necessarily form the reflected wave receiver 27 independently, and a reflected wave receiver may make it build in the reception function of the ultrasonic transducer 20.
[0050] Next, with reference to drawing 2 , the working principle of the Doppler type ultrasonic flowmeter 10 is explained.
[0051] As shown in drawing 2 (A), after only the include angle alpha has leaned and installed the ultrasonic transducer 20 in the flow direction of a measured fluid to the radiation direction of the fluid piping 11 When incidence of the ultrasonic pulse of the necessary fundamental frequency f0 is carried out from the ultrasonic transducer 20, as this ultrasonic pulse is reflected in the measured fluid 12 on the measurement line ML in reflectors, such as air bubbles distributed uniformly and a foreign matter, and it is shown in drawing 2 (B) It is set to ultrasonic echo a which is a reflected wave, and is returned to the ultrasonic transducer 20. In addition, in drawing 2 (B), Sign b is a multiple reflection echo reflected with the tube wall by the side of ultrasonic pulse incidence, and Sign c is a multiple reflection echo reflected with an opposite side tube wall. Dispatch spacing of the ultrasonic pulse sent from the ultrasonic transducer 20 is 1-/Frpf.
[0052] And if filtering processing of the echo signal sent by the ultrasonic transducer 20 is carried out and a velocity distribution is measured along with the measurement line ML using the doppler shift method, it will be displayed like drawing 2 (C). This velocity distribution can be measured with the fluid velocity-distribution measurement means 16 of the UVP unit 13.
[0053] If an ultrasonic pulse is emitted into the measured fluid 12 which flows the inside of the fluid piping 11, it will be reflected by the reflector of mixture or uniform distribution into the measured fluid 12, and the doppler shift method will serve as an ultrasonic echo, and will apply the principle in which only the magnitude to which the frequency of this ultrasonic echo is proportional to the rate of flow carries out a frequency shift.
[0054] Moreover, the velocity-distribution signal of the measured fluid 12 measured with the ultrasonic fluid velocity-distribution measurement means 16 can be sent to the computer 17 as a fluid flow rate operation means, can integrate with a velocity-distribution signal to radial [of the fluid piping 11] here, and can calculate the flow rate of the measured fluid 12 by the time-dependent. If the flow rate in the time amount t of this measured fluid 12 is set to m (t), it can express with a degree type.
[0055]
[Equation 1]

$$m(t) = \rho \int v(x \cdot t) \cdot dA \qquad \cdots\cdots(1)$$

但し、ρ：被測定流量の密度

v（x・t）：時間tにおける速度成分（x方向）

[0056] (1) Flowing flow rate [of time amount t] m (t) can rewrite the fluid piping 11 from a formula to a degree type.
[0057]
[Equation 2]

$$m(t) = \rho \iint vx(r \cdot \theta \cdot t) \cdot r \cdot dr \cdot d\theta \qquad \cdots\cdots(2)$$

但し、vx（r・θ・t）：時間tにおける配管横断面上の中心から距離r，

角度θの管軸方向の速度成分

[0058] (2) From a formula, the Doppler type ultrasonic flowmeter 10 can acquire the spatial distribution of the flow of the measured fluid 12 with the speed of response of instant, for example, 50msec(s), - 100msec extent. the case where time fluctuation exists by the case where sufficient run-up section cannot be taken even if the measured fluid 12 is the flow in the fluid piping (tube) 11, closing motion of a valve, a Start pump, a halt, etc. -- the flow of a fluid -- an unstationary state -- three-dimensions distribution -- ****, although it is since this Doppler type ultrasonic flowmeter 10 can search for the velocity distribution of a measurement field by the time-dependent in an instant -- the flow rate of the measured fluid 12 -- a steady state and an unstationary state -- how cannot be asked but it can ask with a sufficient precision correctly.

[0059] Moreover, the verification test of the transparency property of the supersonic wave oscillated from the ultrasonic transducer 20 using the Doppler type ultrasonic flowmeter 10 concerning this invention was performed.
[0060] Drawing 3 is a test result which shows the wall surface transparency property of a supersonic wave.
[0061] The Doppler type ultrasonic flowmeter 10 used for this trial used what minces 5kHz of fundamental frequency of the supersonic wave oscillated from the ultrasonic transducer 20 by the frequency complement setting means 19 from 200kHz to several MHz, for example, 2MHz, comes out, and could be made to carry out an accommodation setup automatically.
[0062] The wall surface radiographic examination of a supersonic wave embeds stainless steel at a part of acrylic piping of 250mmphi, installs the ultrasonic transducer 20 in the exterior of this stainless steel wall, carries out incidence of the supersonic wave, changes fundamental frequency and investigates the reflectivity of the supersonic wave from an acrylic piping opposite side-attachment-wall side. The transparency curves h, i, and j of the reflected wave when changing fundamental frequency by 5kHz unit on the strength are shown.
[0063] In the wall surface radiographic examination of a supersonic wave, the wall thickness of stainless steel prepared three kinds which are 9.5mm, 11.5mm, and 13mm. Drawing 3 shows the example of a wall surface radiographic examination of the supersonic wave by the stainless steel of 9.5mm of wall thickness. An axis of abscissa is the fundamental frequency f0 of a supersonic wave, and an axis of ordinate is the reflectivity of the supersonic wave from an opposite wall. The characteristic frequency of three kinds of used ultrasonic transducers is 0.25MHz, 0.5MHz, and 1MHz, and the transparency curve on the strength is expressed with Signs h, i, and j, respectively.
[0064] On the other hand, in drawing 3 , arrow heads l, m, and n show the oscillation frequency wavelength of a supersonic wave, and the relation of the wall thickness of stainless steel, and show a 1/2, 1 time of the wall thickness of stainless steel, and 3/2 twice as many frequency location as this from the one where ultrasonic wavelength is lower.
[0065] When using a 1MHz ultrasonic transducer, for example, and it doubles with the wall thickness of stainless steel piping, fundamental frequency is set as about 910kHz and flow rate

measurement is performed from drawing 3 , it turns out that the transparency property of a supersonic wave is good. The transparency curve j of a frequency on the strength is understood that the transparency reinforcement of a reflected wave is high in the location of an arrow head n.
[0066] Next, based on the transparency property of the supersonic wave shown in drawing 3 , fluid piping of the carbon steel (bore of 150mm) of 9.5mm of wall thickness was prepared, the thing with a characteristic frequency [of the ultrasonic transducer 20] of 1MHz was used, a selection setup of the fundamental frequency f0 oscillated from the ultrasonic transducer 20 was carried out with the frequency-selective setting means 19 at 910kHz, and the velocity distribution of a measured fluid was measured.
[0067] The time average velocity-distribution result of the measured fluid obtained by this measurement trial is shown in drawing 4 . The measure point of the velocity distribution of a measured fluid was performed in 60mm - 150mm. Although it was more difficult than the tubing core of fluid piping of carbon steel to acquire velocity distribution sufficient for reflection of the supersonic wave in the interior of a wall in a near side (the range of 0mm - 60mm), from the tubing core, in the measurement field by the side of them, the effect of a wall surface did not appear in the velocity distribution of the measured fluid 12, but the comparatively smooth average velocity-distribution curve O was obtained.
[0068] From this average velocity-distribution curve O, by integrating with an average velocity distribution within the fluid piping 11, it is accurate and the flow rate of the measured fluid 12 which flows the inside of the fluid piping 11 can be measured a contacted condition.
[0069] Drawing 5 is drawing showing the 2nd operation gestalt of the Doppler type ultrasonic flowmeter concerning this invention.
[0070] Doppler type ultrasonic flowmeter 10A shown in this operation gestalt changes the wall thickness of the fluid piping 11, and you may make it produce a resonance-transparency phenomenon as an approach of raising the S/N ratio of a reflected wave instead of selecting the optimum frequency of the ultrasonic pulse by which incidence is carried out into the fluid piping 11.
[0071] However, the means by which it is impossible to change the thickness of the fluid piping 11 in practice, and it is equivalent to changing the thickness of the fluid piping 11 is given by changing whenever [champing-angle / of the ultrasonic transducer 20].
[0072] The 2nd operation gestalt carries out an accommodation setup of the alpha with the incident angle accommodation setting means 40 whenever [incident angle / of the ultrasonic pulse oscillated from the ultrasonic transducer 20], and selects automatically whenever [incident angle / of the supersonic wave which suits the wall thickness of the fluid piping 11]. The same sign is given to the same member as the Doppler type ultrasonic flowmeter 10 shown in the 1st operation gestalt, and explanation is omitted.
[0073] Doppler type ultrasonic flowmeter 10A shown in drawing 5 is replaced with the frequency selection setting means 19, and establishes the incident angle accommodation setting means 40.
[0074] The ultrasonic transducer 20 by which the incident angle accommodation setting means 40 was able to prepare whenever [champing-angle] in the fluid piping 11 free [accommodation] from the outside, Whenever [incident angle / of the ultrasonic pulse oscillated from this ultrasonic transducer 20] The incident angle translator 41 which can accommodation set up alpha, Within the limits of the incident angle field specified beforehand, for example, an incident angle field setting means 43 by which alpha operates the incident angle translator 41 possible [change] whenever [incident angle] within the limits of the include-angle field width of face which is five - 45 degrees, Receive the ultrasonic echo reflected from the measurement field in said fluid piping 11, and the reinforcement of an ultrasonic echo is extracted. It has a reflected wave on-the-strength extract means 44 to memorize, and the ultrasonic echo reinforcement extracted and memorized with the reflected wave on-the-strength extract means 44 is displayed with the display 18 equipped with the reflected wave display function on the strength.
[0075] The incident angle translator 41 is a device to which it was made to change alpha in about five - 45 degrees whenever [incident angle / of a supersonic wave], and by the output

signal outputted from this incident angle translator 41, an accommodation setup of said incident angle accommodation setting means 40 is automatically carried out so that whenever [champing-angle / of the ultrasonic transducer 20] may serve as an optimum value. Whenever [champing-angle / of the ultrasonic transducer 20] makes the champing-angle modification adjustment device of for example, stepping motor 46 grade drive with the output signal outputted from the incident angle translator 41, and is enabling an accommodation setup of the modification of whenever [champing-angle / of the ultrasonic transducer 20].

[0076] alpha is an include angle formed between the vertical line on the front face of tubing of the fluid piping 11, or a vertical plane whenever [incident angle / of the supersonic wave oscillated from the ultrasonic transducer 20]. Whenever [incident angle / of the ultrasonic pulse oscillated from the ultrasonic transducer 20], the optimal include angle is set up with the incident angle accommodation setting means 40 so that a resonance-transparency phenomenon may be produced to the wall thickness of the fluid piping 11.

[0077] The angle-of-incidence accommodation setting means 40 changes the incidence include angle of the ultrasonic pulse oscillated from the ultrasonic transducer 20 with the output signal from the incidence angular-transformation device 41 by include-angle within the limits of the angle of incidence of about five - about 45 degrees, extracts reflected wave reinforcement with the reflected wave on-the-strength extract means 44, and is made to memorize. While being displayed with a display 18, extract selection actuation of whenever [incident angle / of an ultrasonic pulse] is repeatedly performed by the incident angle accommodation setting means 40, whenever [optimal incident angle / of an ultrasonic pulse] is chosen automatically, and the reflected wave reinforcement memorized with the reflected wave on-the-strength extract means 44 is selected.

[0078] By carrying out an accommodation setup of the incidence include angle of the ultrasonic pulse oscillated from the ultrasonic transducer 20 by the angle-of-incidence accommodation setting means 40 at the optimal include angle, it becomes equivalent to that to which the wall thickness of the fluid piping 11 was changed physically, and the velocity distribution and flow rate of the measured fluid 12 which flows the inside of the fluid piping 11 can be correctly measured with a sufficient precision by the ultrasonic pulse oscillated from the ultrasonic transducer 20.

[0079] If whenever [incident angle / of the supersonic wave oscillated from the ultrasonic transducer 20] (penetration include angle) is changed, the travelling distance in the matter, i.e., the ultrasonic travelling distance in the fluid piping 11, will change. By doubling ultrasonic travelling distance with the integral multiple of the ultrasonic half-wave length, a resonance-transparency phenomenon can be produced to the wall thickness of the fluid piping 11, sufficient reflected wave S/N ratio can be secured, and the reinforcement of the ultrasonic echo which is a reflected wave can be secured. Therefore, the velocity distribution and flow rate of the measured fluid which flows the inside of the fluid piping 11 can be measured with a sufficient precision by non-contact.

[0080] In addition, although each operation gestalt of a Doppler type ultrasonic flowmeter showed the example equipped with the frequency-selective setting means 19 and the incident angle accommodation setting means 40, respectively, you may make it prepare for one set of a Doppler type ultrasonic flowmeter combining the frequency-selective setting means 19 and the incident angle accommodation setting means 40. If it has combining both the setting means 19 and 40, it will become easy to choose automatically whenever [optimum frequency and optimal incident angle], and to set it up with a Doppler type ultrasonic flowmeter.

[0081] Since the Doppler type ultrasonic flowmeters 10 and 10A shown in drawing 1 thru/or drawing 4 measure the flow rate of a measured fluid by the ultrasonic pulse and the line measuring method of the velocity distribution using the doppler shift of an ultrasonic echo, in order to raise the accuracy of measurement, they need to increase the number of the measurement lines ML, as a result the installation number of the ultrasonic transducer 23. The measurement line ML may do the include-angle alpha inclination of the ultrasonic transducer 20 of N individual to the perpendicular to a tube wall by setting and installing necessary spacing in the hoop direction of piping 11 in fact, and you may set so that all the measurement lines ML may pass along the axis of piping 11.

[0082] Then, supposing the flow of the measured fluid 12 which flows the inside of piping 11 can disregard radial, the flow vr of an include angle theta, and vtheta by the flow of the direction of a tube axis, it is set to vx>>vr and Vx>>vtheta, and it is simplified and flow rate measurement is expressed with a degree type.
[0083]
[Equation 3]

$$m(t)=\sum_{i}^{N}\cdot\frac{2\pi}{N}\int_{-R}^{R}\{vx(r\cdot\theta i\cdot t)/\sin\alpha\}\cdot r\cdot dr \quad \cdots\cdots(3)$$

[0084] Thus, the flow rate of the called-for measured fluid 12 can be displayed by the time-dependent with a display 18 in an instant. The velocity distribution which meets the measurement line ML in the fluid piping 11 of the measured fluid 12, or the velocity distribution in the piping cross section can also be displayed on this display 18.
[0085] Drawing 8 shows the 3rd operation gestalt of the Doppler type ultrasonic flowmeter concerning this invention from drawing 6 .
[0086] As shown in drawing 6 , Doppler type ultrasonic flowmeter 10B shown in this operation gestalt computes the velocity compornent V2 of a direction by the Doppler frequency whenever [ultrasonic incident angle / of the measured fluid 12 which flows the inside of the fluid piping 11] (penetration include angle), searches for the velocity distribution which meets the measurement line ML from this computed Doppler frequency by the line measuring method, and is computing the flow rate of the measured fluid 12.
[0087] In this Doppler type ultrasonic flowmeter 10B, the velocity vector V1 in alignment with the shaft orientations of the fluid piping 11 is computed by computing the velocity vector V2 which meets in the direction of an ultrasonic path (measurement line ML) from the Doppler frequency, and carrying out division process of the velocity vector V2 by sinalpha.
[0088] In this Doppler type ultrasonic flowmeter 10B, if the flow which is parallel within the fluid piping 11 has arisen in the fluid piping 11 when the flow of the measured fluid 12 is not parallel to the fluid piping 11, the right rate of flow is uncomputable. For example, as shown in drawing 7 , when the air bubbles which have a velocity vector V3 exist, since this velocity vector V3 shares the velocity vector V2 of the same direction as the velocity vector V1 of the measured fluid 12, it will compute the rate of the air bubbles of the measured fluid 12 accidentally with the shaft-orientations rate of the big fluid piping 11 seemingly.
[0089] In order to cancel this apparent rate calculation flow rate, Doppler type ultrasonic flowmeter 10B is equipped with two ultrasonic transducers 20 and 20a, and attaches them in the fluid piping 11. One ultrasonic transducer 20 is installed so that ultrasonic transducer 20a of another side may be intersected perpendicularly, and it asks for both velocity vectors V2 and V4 by both the supersonic-waves transducers 20 and 20a, respectively, and enables it to search for correctly the rate of flow of the measured fluid 12, and the rate of flow of air bubbles by computing the vector sum of these velocity vectors V2 and V4.
[0090] This Doppler type ultrasonic flowmeter 10B is taken as the structure which can carry out movable [of the ultrasonic transducer 20a of another side] on the fluid piping 11 to one ultrasonic transducer 20, in order to measure the rate of flow of the measured fluid 12 correctly.

[0091] For this reason, Doppler type ultrasonic flowmeter 10B is equipped with the ultrasonic transducer migration device 46 in which transducer 20a of another side is made to move relatively to one ultrasonic transducer 20, and as shown in the signal-processing block diagram shown in drawing 8 , it is constituted.
[0092] In Doppler type ultrasonic flowmeter 10B shown in drawing 8 , it is arranged so that the direction of incidence of the ultrasonic pulse oscillated from both the supersonic-waves transducers 20 and 20a may intersect perpendicularly mutually within the fluid piping 11. That is, Doppler type ultrasonic flowmeter 10B is arranged so that the ultrasonic pulse oscillated from both the supersonic-waves transducers 20 and 20a may intersect perpendicularly in the measurement field in the fluid piping 11.
[0093] With the reflected wave receivers 27 and 27a with which said Doppler type ultrasonic

flowmeter 10B receives the ultrasonic echo which is a reflected wave, respectively from the measurement field in the fluid piping 11 of the ultrasonic pulse oscillated from both the supersonic-waves transducers 20 and 20a Velocity vector calculation means 47 and 47a to compute the velocity vector of the direction of an ultrasonic measurement line, respectively from the ultrasonic echo reinforcement received with each reflected wave receivers 27 and 27a, It has a rate-of-flow vector calculation means 48 to compute the rate-of-flow vector of a measured fluid from the vector sum of the velocity vector computed with each velocity vector calculation means 47 and 47a. The flow rate of the measured fluid 12 is computed from the velocity distribution of the direction ML of a measurement line in the fluid piping 11 computed with the rate-of-flow vector calculation means 48.

[0094] And the ultrasonic echo of the reflected wave reflected from the measurement field in the fluid piping 11 of the ultrasonic pulse oscillated from both the supersonic-waves transducers 20 and 20a is received by each reflected wave receivers 27 and 27a, respectively. The signal of the ultrasonic echo received with each reflected wave receivers 27 and 27a on the strength is changed into the velocity vector of the measurement line ML direction (the direction of a path) by the velocity vector calculation means 47 and 47a. The vector sum of the velocity vector of the acquired direction of a path is computed with the rate-of-flow vector calculation means 48, and the right velocity vector of the measured fluid 12 rate of flow is computed.

[0095] The above-mentioned velocity vector calculation means 47 and 47a and the rate-of-flow vector calculation means 48 constitute the velocity-distribution measurement circuit 30, or the velocity distribution of the measured fluid 12 of the measured fluid 12 which flows the inside of the fluid piping 11 is measured along the direction ML of a path (measurement line), and the flow rate of the measured fluid 12 can be calculated by carrying out the operation which integrates with this velocity distribution in the direction of a path of a supersonic wave.

[0096] The data in the location of a degree are extracted by moving the fluid piping 11 top for the ultrasonic transducers 20 or 20a by the ultrasonic transducer migration device 46 after computing the rate of flow of the location which is the rate-of-flow vector calculation means 48 of the velocity-distribution measurement circuit 30. By carrying out migration actuation of the ultrasonic transducers 20 and 20a one after another by the ultrasonic transducer migration device 46, the whole can be asked for the velocity distribution of the measured fluid 12 covering the direction of a path of an ultrasonic pulse, and the flow rate can be correctly calculated by the operation.

[0097]

[Effect of the Invention] In the Doppler type ultrasonic flowmeter concerning this invention Establish the frequency-selective setting means which carries out a selection setup of the oscillation frequency of the ultrasonic pulse oscillated from the transducer of a supersonic wave automatically, or Moreover, since the incident angle accommodation setting means which carries out a selection setup of whenever [incident angle / of the ultrasonic pulse oscillated from an ultrasonic transducer] at the optimal include angle was established It can be automatically set as whenever [optimum frequency / of the supersonic wave which produces a resonance-transparency phenomenon to the wall thickness of fluid piping /, or optimal incident angle]. easy in the flow rate of the measured fluid which does not need to prepare the optimal ultrasonic transducer for every various fluid piping, has high versatility, and flows the inside of fluid piping -- and it is correctly [easily and] measurable with a sufficient precision in the state of non-contact.

[0098] Moreover, with the Doppler type ultrasonic flowmeter concerning this invention, the flow rate of a measured fluid can be correctly measured with a sufficient precision using the doppler shift of a supersonic wave, and with an optical hydrometry means, even if it is the opaque or translucent fluid which cannot be measured, the fluid which a revolution style, a vortex, and the flow that is not parallel have produced within fluid piping can also be correctly measured with a sufficient precision.

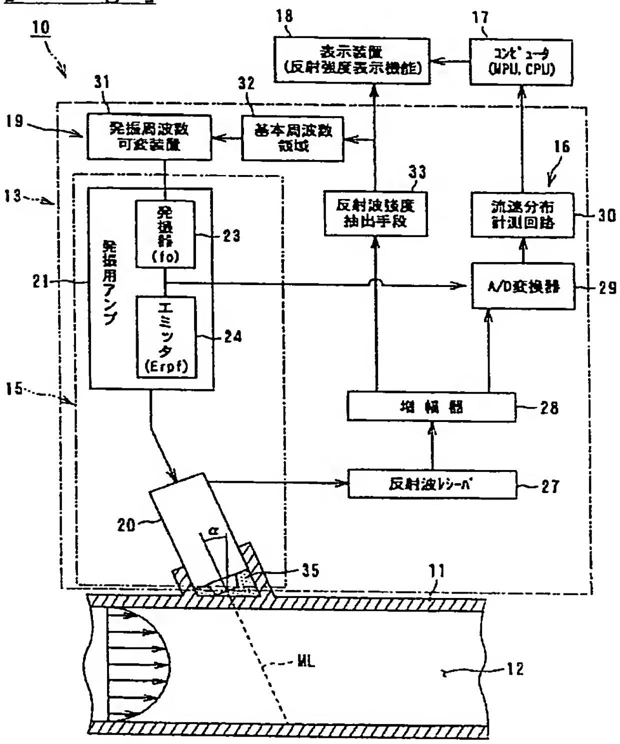
[Translation done.]

* NOTICES *

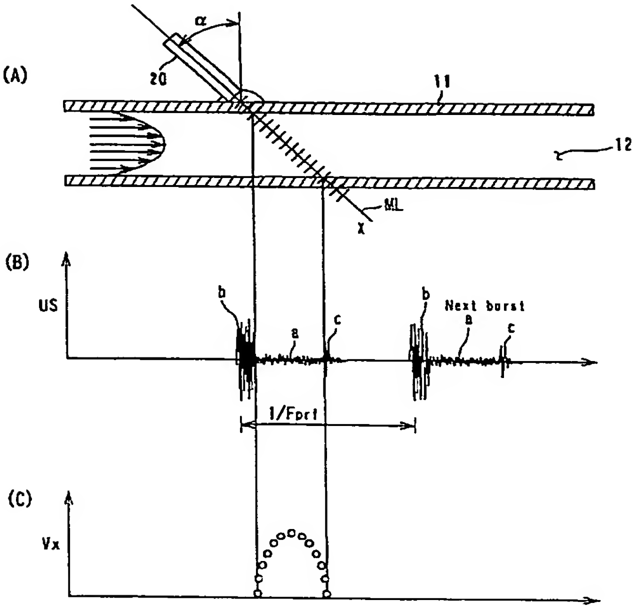
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

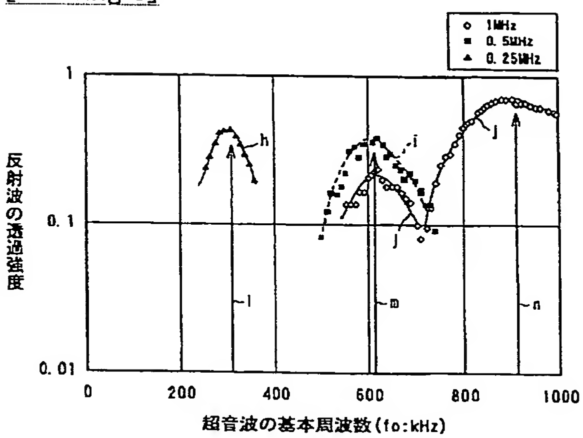
[Drawing 1]



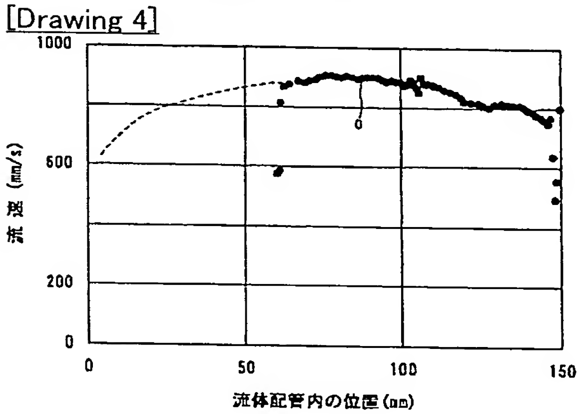
[Drawing 2]



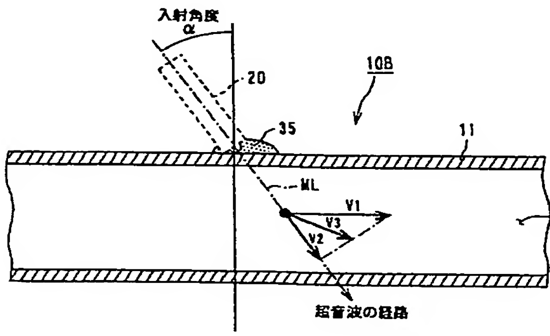
[Drawing 3]



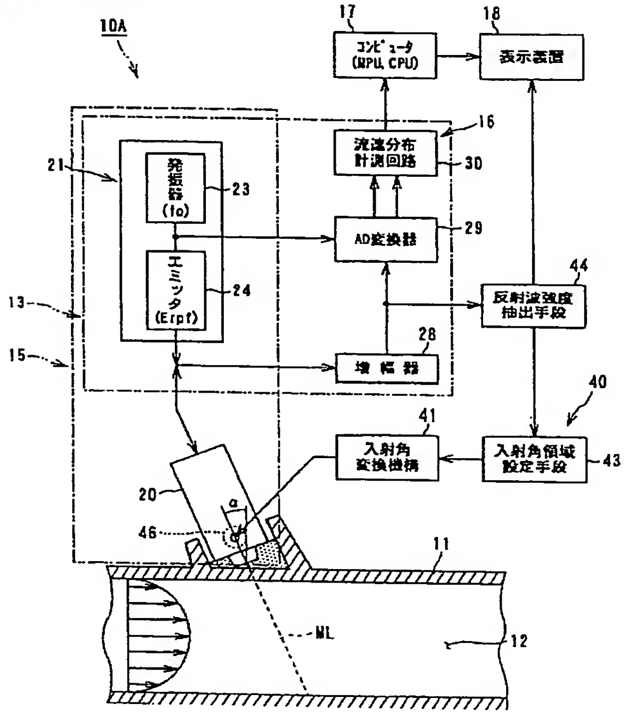
[Drawing 4]



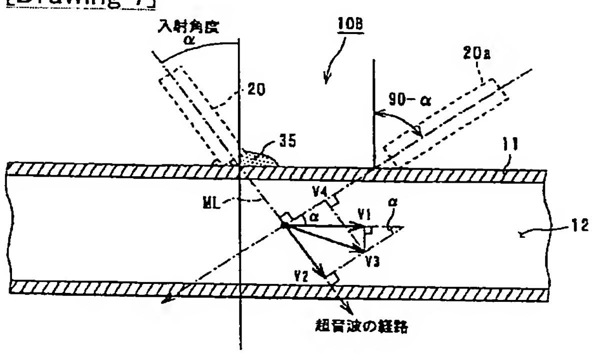
[Drawing 6]



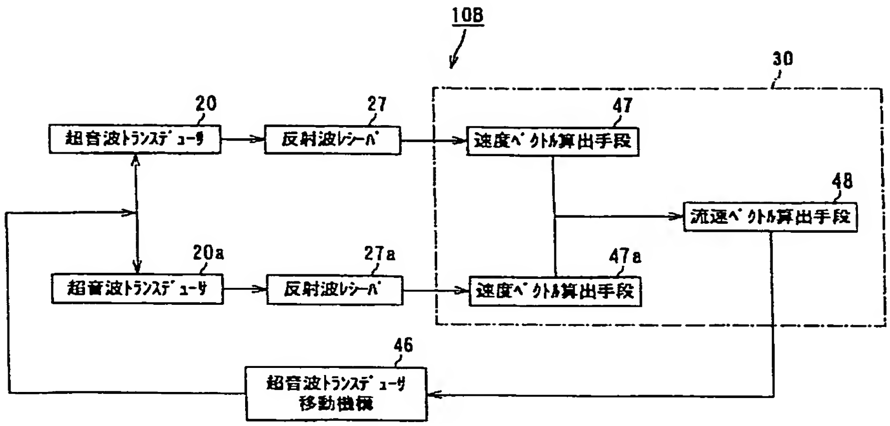
[Drawing 5]



[Drawing 7]



[Drawing 8]



[Translation done.]